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ABSTRACT

Developed for the purpose of providing teachers and administrators with objectives upon which a curriculum could be formed, this guide identifies standardized learner outcomes for secondary level science students. A philosophy of science education for Oklahoma schools is presented and student goals are specified. Objectives and descriptive statements for each discipline area are stated. These subject areas include: (1) general science; (2) earth science; (3) physical science; (4) biology I; (5) biology II; (6) chemistry I; (7) chemistry II; (8) botany; (9) zoology; (10) physiology and anatomy; and (11) physics. (ML)

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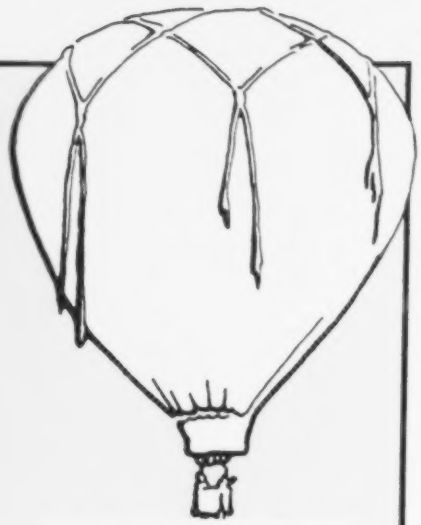
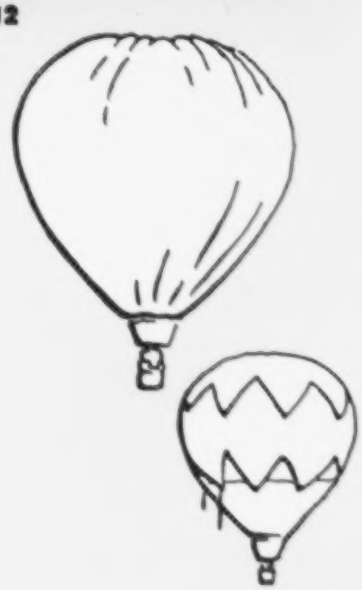
Suggested Learner Outcomes

Grades 9 - 12





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State Department of Education
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SCIENCE

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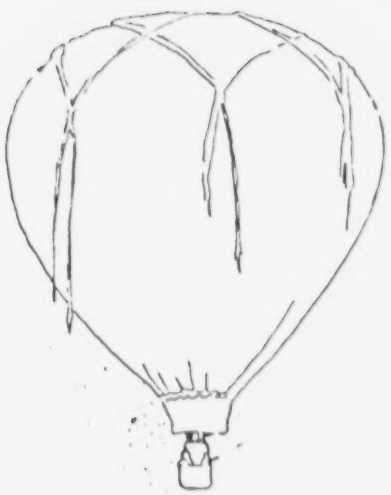
Suggested Learner Outcomes



SCIENCE

Oklahoma State Department of Education
John M. Folks, State Superintendent
Oklahoma City, Oklahoma
July, 1985

FOREWORD

During the academic year 1983–84, the Oklahoma State Department of Education began the process of producing standardized suggested learner outcomes in the five areas of Language Arts, Science, Math, Reading and Social Studies for grades 1 through 8. The goal was to have some stated objectives upon which teachers and administrators could build a solid curriculum which would ultimately provide a better education for the students of Oklahoma.

This process was continued during the 1984–85 year in the same five subject areas for grades 9 through 12. Secondary school foreign language learner outcomes were also devised for Spanish, French, German and Latin. Dozens of persons participated in the process and in June, 1985, a second large group of teachers and administrators met to validate the learner outcomes. The booklet you have in your hand is the result of all this effort and we sincerely hope that it will be of assistance as you plan for effective teaching and learning in the classroom.

John M. Folks

John M. Folks
State Superintendent

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A PHILOSOPHY OF SCIENCE EDUCATION

Science education creates a relationship between science and society with the ultimate goal being the development of a scientifically literate citizenry.

The study of science is an interaction of people and natural phenomena based upon human curiosity as a self-motivating learning force. The primary purpose of science is that people might effectively interact with the comprehensive environment in which they live.

This guiding philosophy of science education is critical to appreciation, problem solving, decision making and establishment of values in order to live today as well as to responsibly cope with the future characterized by change and a complex set of technical and ethical questions.

Fundamental to the study of secondary science is a need for the student to achieve the following goals:

1. understand the nature of science and the scientific enterprise;
2. have knowledge of the major concepts, principles, laws, and theories of science and apply them in appropriate ways;
3. use the processes of science in problem solving and decision making;
4. understand the partnership and interaction of science and technology and its impact on society;
5. possess attitudes and values that are in harmony with those of science and a free society;
6. develop science-related skills that enable an individual to function effectively in careers, leisure activities, and other roles;
7. develop interests which lead to a richer more satisfying life that will include science and lifelong learning;
8. have knowledge of basic computer skills.

Note: Rapid developments in scientific technology will require periodic addition of new concepts to this publication.

GENERAL SCIENCE

General Science will allow the student to:
Gain a general understanding of living and nonliving systems.
Develop an understanding of the processes and methods of scientific approach.
Develop an *appreciation* of how science applications relate to everyday life.

Objectives

1. The student will recognize the need to learn scientific processes that relate to current environmental concerns. These *basic concerns* should include:
   health,
   conservation of resources,
   ethics,
   aesthetics,
   superstitions, and
   cultural needs.
2. The student will use the *basic process skills* to solve problems or answer questions about the environment. These basic skills include:
   Observing—use of senses
   Measuring—use of instrumentation
   Classifying—recognizing patterns
   Communicating—getting and giving information
3. The student will use *integrated skills* that relate to the basic process skills, including:
   describing,
   recalling,
   comparing,
   communication,
   experimentation, and
   hypothesizing.
4. *For enrichment* these integrated skills include:
   inferring,
   deducing,
   imagining,
   analyzing, and
   interpreting data.

   The laboratory experience will allow the student to demonstrate skills toward laboratory safety, equipment and procedures. Emphasis should be on safety rules, equipment and apparatus usage, measuring and recording skills, and formula application.

   The student will demonstrate knowledge of how modern technology applies these basic processes and skills for an improved standard of living.

General Science will include the study of physical, earth and life sciences.

Physical Science

GSP.1 The student will gain knowledge of matter as related to its phases and properties.
Descriptive Statement: Emphasis will be on chemical and physical properties of matter and its phases.

GSP.2 The student will gain knowledge of various physical models.
Descriptive Statement: Emphasis should be on models which demonstrate atomic and molecular structure, wave motion, and simple machines.

GSP.3 The student will gain knowledge of the periodic table and the information contained therein.
Descriptive Statement: Atomic number, atomic mass, electron arrangement, and periodicity are topics to be introduced.

GSP.4 The student will gain knowledge of nuclear energy through models and diagrams.
Descriptive Statement: Emphasis will be placed upon sources, reactors, safety, benefits, hazards and types of radiation.

GSP.5 The student will gain knowledge of energy and investigate its forms and changes.
Descriptive Statement: The forms and changes to be presented are kinetic and potential, heat, light, mechanical, chemical, nuclear, electromagnetic, sound and reflection, refraction, color, static electricity, current electricity, magnetism and any form changed to another.

GSP.6 The student will gain knowledge of the principles of work, force, and power as related to simple machines.
Descriptive Statement: Simple machines will be used to illustrate these principles.

GSP.7 The student will gain knowledge of laws of motion and their related forces.
Descriptive Statement: Emphasis will be on Newton's Laws of acceleration, inertia, and action/reaction.

Earth Science

GSE.1 The student will gain knowledge of the surface characteristics of the earth and how maps relate to them.
Descriptive Statement: Characteristics to be studied include size, shape, motion, seasons, and mapping.

GSE.2 The student will gain knowledge of properties of rocks and minerals and changes that occur in the earth's surface.
Descriptive Statement: Structure of the earth, plate tectonics, rocks and minerals, weathering and erosion, and rock formations should be emphasized.

GSE.3 The student will gain knowledge of the earth's life forms and how they have developed during geologic time.
Descriptive Statement: Sedimentation, age of rocks, study of fossils, geologic time, and the earth's future should be studied.

GSE.4 The student will gain knowledge about the major features of the atmosphere.
Descriptive Statement: Major features of the atmospere include layers of atmosphere, barometric pressure, energy systems, humidity, clouds, and precipitation.

GSE.5 The student will gain knowledge of factors that effect weather and its summative effect on climate.
Descriptive Statement: Emphasis will be on air masses, fronts, pressure systems, storm systems, weather maps, and forecasting.

GSE.6 The student will gain knowledge of the major features of the oceans.
Descriptive Statement: Major features of the oceans to be studied are chemical and physical properties of seawater, sea floor, sea life, currents, waves, tides, seismic waves, and resources.

GSE.7 The student will gain knowledge of how astronomers study the universe.
Descriptive Statement: Emphasis will be on optical telescopes, radio telescopes, satellites, spectrascopes, and parallax system of measurement.

GSE.8 The student will gain knowledge of the features and relationships among the members of our solar system.
Descriptive Statement: Study of our solar system includes the moon and its motions, planets and their motions, the sun and its activity, asteroids, meteors, and comets.

GSE.9 The student will gain knowledge of some of the properties of stars and galaxies.
Descriptive Statement: Properties of stars and galaxies include stellar distance, classification, star development, types of galaxies, and constellations.

GSE.10 The student will gain knowledge of space exploration.
Descriptive Statement: The study of space exploration should emphasize types of rockets, satellites, manned programs, and man's future in space.

Life Science

GSL.1 The student will gain knowledge of the continuity and diversity of living things.
Descriptive Statement: Emphasis will be on characteristics of living things, the cell and its activities, classification and taxonomy.

GSL.2 The student will gain knowledge of the characteristics of plants.
Descriptive Statement: Vascular plants and nonvascular plants, photosynthesis, reproduction, and plant life cycle are important in studying this concept.

GSL.3 The student will gain knowledge of the characteristics of animals.
Descriptive Statement: Animal characteristics to be studied include cells, tissues, organs, and systems of vertebrates and invertebrates.

GSL.4 The student will gain knowledge of the relationships between living things (biotic and abiotic) and their environment.
Descriptive Statement: Relationships to be emphasized are communities, populations, food chains, producers, consumers, and extinction.

GSL.5 The student will gain knowledge of the organizational levels of the human body.
Descriptive Statement: Cells, tissues, organs, and systems will be studied.

GSL.6 The student will gain knowledge of body processes and how they interrelate to keep a person alive and healthy.
Descriptive Statement: Body processes to be studied include reproduction, respiration, digestion, excretion, regulation, nutrition, immunity and disease, drugs, and preventive medicine.

GSL.7 The student will demonstrate knowledge of how modern technology applies basic processes and skills for an improved standard of living.
Descriptive Statement: The student will investigate careers and professional opportunities that utilize scientific knowledge and technology.

EARTH SCIENCE

ES.1 The student will develop an understanding of the earth.
Descriptive Statement: Investigations should include origin, motion, shape, size, and composition of the earth.

ES.2 The student will be able to recognize the cause of seasonal changes on the earth.
Descriptive Statement: The tilt of the earth causes seasonal changes.

ES.3 The student will understand the interrelationship between the hydrosphere, atmosphere, and lithosphere.
Descriptive Statement: Investigations should include the characteristics of the hydrosphere, atmosphere, and lithosphere.

ES.4 The student will develop a knowledge of the geological history of the earth.
Descriptive Statement: Investigations should include historical implications revealed by fossils and layers of rock.

ES.5 The student will understand forces acting upon the earth.
Descriptive Statement: Investigations should include wind, surface water, ground water, volcanic activity, glaciers, gravity, earthquakes, and continental movement.

ES.6 The student will evaluate methods of conserving natural resources.
Descriptive Statement: Students could investigate soil, air, water, minerals, fossil fuels, plants, and wildlife.

ES.7 The student will be able to understand how the earth compares to other planets.
Descriptive Statement: Encourage the use of models of planets including the sun in the solar system.

ES.8 The student will gain knowledge of space exploration.
Descriptive Statement: The study of space exploration should emphasize types of rockets, satellites, manned programs, and man's future in space.

ES.9 The student will recognize the importance of weather.
Descriptive Statement: Constructive and destructive forces are changing the earth.

ES.10 The student will learn to determine locations and time zones on the earth.
Descriptive Statement: Studies should include longitude, latitude, and time zones.

ES.11 The student will be able to distinguish between fact, theory, and hypothesis.
Descriptive Statement: Investigations could be related to given explanations of earth-related phenomena.

ES.12 The student will be able to identify the major minerals and rocks of the earth.
Descriptive Statement: The student demonstrates this ability by identifying rocks and minerals in the laboratory.

ES.13 The student will develop an understanding of important cycles.
Descriptive Statement: Investigations could include nitrogen, carbon dioxide, oxygen, water, and rock cycles.

ES.14 The student will be able to differentiate practices which help or harm our environment.
Descriptive Statement: Investigations could include strip mining, water pollution, air pollution, waste water, noise, and radioactive waste disposal.

ES.15 The student will develop an interest in earth science.
Descriptive Statement: A list of resource personnel and field trip locations, should be compiled and utilized to stimulate student interest.

ES.16 The student will demonstrate knowledge of how modern technology applies basic processes and skills for an improved standard of living.
Descriptive Statement: The student will investigate careers and professional opportunities that utilize scientific knowledge and technology.

PHYSICAL SCIENCE

Goals:

The student will gain general understanding of chemical and physical relationships.

The student will develop an understanding of the processes and methods of scientific approach.

The student will develop an appreciation of how science applications relate to everyday life.

Objectives:

The student will use the basic process skills to solve problems or answer questions about the physical environment.

These *basic skills* include:
Observing—the senses
Measuring—instrumentation
Classifying—recognizing patterns
Communicating—feedback

Integrated skills that relate to the basic skills should be utilized by all students and include:
Describing
Recalling
Comparing
Communication
Experimentation
Hypothesizing

Integrated skills for *enrichment* should include:
Inferring
Deduction
Imagining
Analyzing
Interpreting Data

Concepts of Physical Science:

The concepts appear in some logical instructional sequence, however, it is realized that sequencing of concepts will vary as the learning activities are individualized for the student.

PS.1 The student will demonstrate safe laboratory procedures.
Descriptive Statement: Emphasis will be placed on safety rules, equipment and apparatus usage, measuring and recording skills, and following instructions.

PS.2 The student will acquire a concept of matter as related to its classes and properties.
Descriptive Statement: Classes of matter introduced will be elements, compounds, and mixtures. Properties of matter discussed will be chemical and physical.

PS.3 The student should be familiar with various physical models.
Descriptive Statement: Some examples of models for this area are atomic, kinetic-molecular, wave, structural-molecular, and simple machines.

PS.4 The student will gain knowledge of the periodic table and the information contained therein.
Descriptive Statement: Atomic number, atomic mass, electron configuration and periodicity are topics to be introduced.

PS.5 The student will gain a knowledge of compound formulation, their composition, and their properties.
Descriptive Statement: Formulas, chemical reactions, and chemical equations should be studied.

PS.6 The student will acquire a knowledge of energy and investigate its forms and changes.
Descriptive Statement: The forms and changes to be presented are: kinetic and potential, heat, light, mechanical, chemical, nuclear, electromagnetic, sound, reflection, refraction, color, static electricity, circuits, current electricity, and magnetism.

PS.7 The student will study nuclear energy through models and diagrams.
Descriptive Statement: Emphasis will be placed upon sources, reactors, safety, benefits, hazards, and types of radiation.

PS.8 The student will investigate the principles of work, force, and power as related to simple machines.
Descriptive Statement: Examples to be introduced are inclined planes, levers, screws, gears and pulleys, as well as the forces and time involved with each.

PS.9 The student will demonstrate knowledge of laws of motion and their related forces.
Descriptive Statement: The student will investigate Newton's laws of acceleration, inertia, and action-reaction.

PS.10 The student will demonstrate knowledge of how modern technology applies basic processes and skills for an improved standard of living.
Descriptive Statement: The student will investigate careers and professional opportunities that utilize scientific knowledge and technolgy.

PS.11 The student will develop an interest in physical science.
Descriptive Statement: A list of resource personnel and field trip locations should be compiled and utilized to stimulate student interest.

BIOLOGY I

BI.1 The student will use basic process skills.
Descriptive Statement: Basic process skills are:
a. observing—using the five senses and appropriate equipment such as microscopes;
b. classifying—using dichotomous keys;
c. communicating—sharing information or data verbally and/or through writing, drawings, and graphs;
d. investigating—collecting and recording data about organisms through a hands-on manipulative manner;
e. interpreting—arranging data to look for cause and effect;
f. measuring—making comparison by using familiar objects and metric measurements;
g. model-building—study should enable students to construct models which illustrate various biological concepts.

BI.2 The student will use chemicals, scientific tools, and equipment in a safe and appropriate manner.
Descriptive Statement: Examples of science equipment include such tools as hand lenses, metric rulers, balances, microscopes, dissecting instruments, and computers.

BI.3 The student will demonstrate proper handling and care of organisms (plants, animals, and protists) and show respect for life and property.
Descriptive Statement: Provisions should be made for maintaining the health and safety of students and organisms.

BI.4 The student will work independently and as a member of small and large groups within the classroom and in the appropriate laboratory.
Descriptive Statement: Experiences will provide the opportunity to develop independence, cooperative skills, and attitudes as a part of social growth.

BI.5 The student will identify cell structures, cells, tissues, and their functions.
Descriptive Statement: Students will observe cell structure and tissues using a microscope and drawings. From these observations they will be able to identify major cell structures, cells, tissues and their functions.

BI.6 The student will classify organisms according to similarities and differences.
Descriptive Statement: Observable characteristics of several organisms will be compared. A dichotomous key may be introduced. Students should be aware of scientific classification schemes and of binomial nomenclature.

BI.7 The student will recognize that organisms carry on metabolic processes to maintain life.
Descriptive Statement: Gas exchange and transport, cellular respiration, digestion, absorption and assimilation in plants and animals, use of enzymes, vitamins, and minerals are topics that can be taught in laboratory or lecture.

BI.8 The student will recognize plants as producers of food and oxygen.
Descriptive Statement: The sun is the ultimate source of energy. The students will perform experiments and interpret data illustrating the process of photosynthesis.

BI.9 The student will illustrate the movement of materials through food chains, food webs, and pyramids.
Descriptive Statement: Through a variety of observations of local flora and fauna the students will interpret food chains, webs, and pyramids.

BI.10 The student will identify living and nonliving things in the ecosystem.
Descriptive Statement: Living and nonliving factors of local ecosystems and their interactions will be compared and contrasted through a variety of observations.

BI.11 The student will describe methods of conserving our present living resources.
Descriptive Statement: Activities should include topics such as extinct, endangered, threatened species and destruction of habitat.

BI.12 The student will study basic principles of genetics.
Descriptive Statement: Topics may include RNA, DNA, chromosomes, mutations and laws of genetics.

BI.13 The student will study changes that occur in organisms.
Descriptive Statement: Adaptation and natural selection as means of change should be studied.

BI.14 The student will examine the internal structures of representative organisms.
Descriptive Statement: Various structures and systems will be examined.

BI.15 The student will develop a basic understanding of the major characteristics of invertebrates.
Descriptive Statement: The major characteristics of invertebrate phyla will be presented through the study of several organisms.

BI.16 The student will compare major characteristics of vertebrates.
Descriptive Statement: Several examples of vertebrate classes and orders will be examined and their structures compared.

BI.17 The student will identify the major structures of vascular and nonvascular plants.
Descriptive Statement: Vascular and nonvascular plants will be studied for comparative purposes.

BI.18 The student will study the process of reproduction in several organisms.
Descriptive Statement: Activities will include interpreting that sexual reproduction is a process by which new individuals are formed from the union of the sperm and egg, and observing examples of asexual reproduction such as binary fission, budding, regeneration, and vegetative propagation.

BI.19 The student will observe that organisms receive and respond to stimuli from the environment.
Descriptive Statement: Topics to be investigated are:
a. reflexes;
b. sensory structures;
c. reactions to specific stimuli such as the avoidance reaction; and
d. chemical response.

BI.20 The student will study major characteristics of virus, bacteria, protozoa, algae, and fungi.
Descriptive Statement: Several examples of these organisms will be examined and their structure compared.

BI.21 The student will develop an interest in biology.
Descriptive Statement: A list of resource personnel, field trip locations, etc. should be compiled and utilized to stimulate student interest.

BI.22 The student will study principles of cellular transport.
Descriptive Statement: Examples should include osmosis, diffusion, and active transport.

BIOLOGY II

BII.1 The student will experience reinforcement and expansion of the skills and concepts introduced in Biology I.
Descriptive Statement: Activities that review the Biology I concepts should be included.

BII.2 The student will identify basic cell organelles and their functions.
Descriptive Statement: Activities should include some of the following:
a. observations of cells and cell organelles;
b. model-building of cells and the organelles;
c. identification of the role of the cell organelles;
d. examination of various tissues.

BII.3 The student will recognize the major processes in photosynthesis.
Descriptive Statement: Photosynthesis will be examined to identify the following:
a. chemical processes;
b. role of light;
c. role of chlorophyll.

BII.4 The student will recognize that energy is released during cellular respiration.
Descriptive Statement: Activities should include examples of aerobic and anaerobic respiration and the role of enzymes in respiration.

BII.5 The student will identify the processes of digestion in humans.
Descriptive Statement: Experiments should illustrate mechanical and chemical processes.

BII.6 The student will identify processes involved in gaseous exchange and transport in humans.
Descriptive Statement: The student will examine models and perform experiments to illustrate how respiratory and circulatory systems function.

BII.7 The student will identify the skeletal muscles and the major bones of the skeleton.
Descriptive Statement: Examine bone structure and compare types of bones. Show that muscles and bones work together.

BII.8 The student will identify the role of genes and chromosomes in determining the characteristics of individual organisms.
Descriptive Statement: Studying traits will illustrate principles of genetics.

BII.9 The student will recognize that mitosis produces new cells in organisms.
Descriptive Statement: The student will realize that changes occur in mitosis.

BII.10 The student will study meiosis.
Descriptive Statement: Examine the role of meiosis in keeping the chromosome number constant from generation to generation.

BII.11 The student will study the diversity of organisms.
Descriptive Statement: Compare organisms and classify the organisms into groups. Identify characteristics specific to each group. Activities may include use of dichotomous key or comparative anatomy studies.

BII.12 The student will identify the mechanisms of response in organisms.
Descriptive Statement: Studies should include the following:
a. hormones;
b. nervous system;
c. sense organs;
d. behavior; and
e. chemicals.

BII.13 The student will study principles of ecology.
Descriptive Statement: Daily, seasonal, and long-term changes which occur in ecosystems should be studied.

BII.14 Students will study reproduction and development of plants and animals.
Descriptive Statement: Studies should include anatomy, physiology, fertilization, and early stages of development.

CHEMISTRY I

CHI.1 The student will demonstrate laboratory procedure and safety.
Descriptive Statement: This will be illustrated by:
a. identification of variables in the experiment;
b. application and usage of equipment;
c. application of scientific method;
d. location and use of safety materials;
e. wearing safety apparel.

CHI.2 The student will demonstrate an understanding of the atomic model.
Descriptive Statement: This will be accomplished by the study of:
a. atomic particles;
b. historical models;
c. present day models;
d. orbital shapes: s, p, d, f, and the number of each;
e. mass number and atomic number;
f. isotopes;
g. average atomic mass;
h. atomic theory.

CHI.3 Mathematical skills will be used by the student to solve problems in chemistry.
Descriptive Statement: The skills emphasized will be:
a. International System of Measurement;
b. scientific notation;
c. arithmetic operations;
d. graphing;
e. ratio and proportion;
f. factor-label method for conversions;
g. accuracy and precision;
h. significant figures;
i. combining SI units to form derived units.

CHI.4 The student will demonstrate an ability for balancing chemical equations and formula development.
Descriptive Statement: This will be illustrated by:
a. symbols;
b. coefficients and subscripts;
c. oxidation numbers;
d. monatomic and polyatomic ions;
e. nomenclature;
f. empirical and molecular formulas;
g. reactants and products;
h. types of reactions;
i. formula units;
j. parts of chemical equations.

CHI.5 The student will demonstrate ability in the usage of the periodic table.
Descriptive Statement: This ability will be developed by studying:
a. historical development;
b. families/groups and periods/series;
c. periodic properties;
d. electron configurations;
e. basis for modern periodic law;
f. differences between metals, nonmetals, and metalloids.

CHI.6 The student will use stoichiometric and quantitative relationships to solve a given chemical problem.
Descriptive Statement: The following concepts will be developed quantitatively for solving problems:
a. mole concept;
b. mass-mass;
c. molecular and formula mass (weight);
d. percentage composition;
e. Avogadro's principle;
f. mass-volume;
g. volume-volume;
h. molar solutions;
i. limiting reactants.

CHI.7 The student will interpret chemical bonding in terms of electrostatic force.
Descriptive Statement: This will be developed by studying:
a. properties of electron, protons, and neutrons;
b. attraction of unlike charges;
c. covalent and ionic bonding;
d. electronegativity
e. ionization;
f. electron affinity;
g. atomic and ionic radii.

CHI.8 The student will study chemical equilibrium.
Descriptive Statement: The nature of equilibrium systems will be described by studying the following:
a. Le Chatelier's principle;
b. factors affecting equilibrium;
c. properties of acids, bases, and salts;
d. reversible reactions;
e. reaction rate and activation energy;
f. characteristics of acid-base theories;
g. formulas of acids and bases;
h. describing and predicting anhydrides;
i. strengths of acids and bases.

CHI.9 The student will gain an understanding of the classes of matter and their properties.
Descriptive Statement: This will be accomplished by exploring the following topics:
a. classes of matter;
b. physical and chemical changes;
c. endothermic and exothermic reactions;
d. heat of formation;
e. phases of matter;
f. elements and compounds;
g. extensive and intensive properties;
h. methods of physical separation.

CHI.10 The student will study the gas laws.
Descriptive Statement: This will be accomplished by studying the following:
a. characteristics of gases;
b. standard conditions;
c. application of Charles's, Boyle's, and the ideal gas law;
d. Dalton's law of partial pressure;
e. limiting reactants.

CHI.11 The student will relate the behavior of matter with the kinetic theory.
Descriptive Statement: This relationship will be accomplished by examinig the following areas:
a. assumptions of the kinetic theory;
b. effect on the phases of matter;
c. factors that affect molecular motion (pressure, temperature).

***CHI.12** The student will be introduced to the chemistry of carbon compounds.
Descriptive Statement: This will be carried out by exploring:
a. classification of organic substances;
b. nomenclature of organic compounds;
c. properties and uses;
d. isomers.

***CHI.13** The student will gain an exposure to nuclear chemistry.
Descriptive Statement: This exposure should include:
a. forms of radiation (alpha, beta, gamma);
b. half-life;
c. subatomic particles related to nuclear chemistry.

***CHI.14** The student will investigate oxidation-reduction reactions.
Descriptive Statement: Investigations should include:
a. characteristics of oxidations and reductions;
b. determining oxidation numbers;
c. balancing redox equations.

***CHI.15** The student will become aware of some of the practical applications of electrochemistry.
Descriptive Statement: This awareness will be accomplished by examining:
a. practical applications of chemical conductivity;
b. types of electrochemical cells (voltaic and electrolytic);
c. electricity produced from a chemical voltaic cell.

***CHI.16** The student will develop an interest in chemistry.
Descriptive Statement: A list of resource personnel, field trip locations, etc. should be compiled and utilized to stimulate student interest.

*These are enrichment topics for advanced studies.

CHEMISTRY II

The study of Chemistry II should include a comprehensive review and study of the materials covered in Chemistry I. In addition to these items, the following should be introduced or reinforced:

CHII.1 The student will become more aware of career opportunities in chemistry.

CHII.2 The student will be exposed to a review and continued emphasis in the use of mathematical skills in solving problems in chemistry.

CHII.3 The student will expand quantitative relationships by examining molarity, normality, formality, and mola

CHII.4 The student will explore energy changes in matter.

CHII.5 The student will examine some of the properties of materials as a result of hybrid orbitals.

CHII.6 The student will further study equilibrium systems by working with equilibrium constants.

CHII.7 The student will gain further understanding of inter- and intra-molecular forces.

CHII.8 The student will study activation energy and catalysis.

CHII.9 The student will learn more organic chemistry including a study of polymers and differentiating types of organic reactions.

CHII.10 The student will gain a greater exposure to nuclear chemistry.
Descriptive Statement: This will be accomplished by examining:
a. nuclear instruments and apparatus;
b. nuclear equations dealing with transmutations;
c. practical uses of radioactive nuclides;
d. fission and fusion reactions.

CHII.11 The student will study more about oxidation-reduction.
Descriptive Statement: This study should include:
a. balancing redox reactions;
b. identifying reactions as redox or nonredox;
c. oxidizing and reducing agents.

CHII.12 The student will gain additional knowledge of electrochemistry by investigating the characteristics of electrolytes.

BOTANY

(½–1 unit)

Botany is a science course designed to help the student acquire habits of critical and creative thinking about plants. The student will also develop a natural curiosity and appreciation for plants. Research of various ideas and scientific theories will result in respect for other plant sciences and give the student experiences in both oral and written communication of data. The student will learn scientific terms, concepts, and principles, and develop skills with laboratory equipment.

BT.1 The student will study the history of botany.
Descriptive Statement: A brief view will be given the student on the history of botany from ancient to present time.

BT.2 The student will learn the structure and organization of seed plants.
Descriptive Statement: The student will become knowledgeable of the gross structures of the seed plants including the roots, stems, leaves, cones, and flowers.

BT.3 The student will use microscopes to study plant structure.
Descriptive Statement: The student will identify organelles, cells, and simple and complex plant tissues.

BT.4 The student will study the needs of plants for soil and water.
Descriptive Statement: The student will learn the effects of soil, water, and minerals on plants.

BT.5 The student will learn the structure and functions of roots.
Descriptive Statement: The students will learn the types of roots, the internal parts of roots, and their functions.

BT.6 The student will learn the structure and functions of stems.
Descriptive Statement: The students will learn stem differences, external parts, bud arrangements, specialized aerial stems, specialized underground stems, and the functions of stems.

BT.7 The student will learn horticultural techniques.
Descriptive Statement: The student will learn about pruning, girdling, budding, grafting, and other techniques pertaining to horticulture.

BT.8 The student will learn the structure and function of leaves.
Descriptive Statement: The Student will learn about:

a. internal structures and functions;
b. external features of leaves;
c. venation;
d. simple and compound leaves;
e. modified leaves;
f. leaf arrangement;
g. leaf pigments;
h. annual leaf drop;
i. photosynthesis and respiration (IN DETAIL);
j. other processes of leaves (transpiration, guttations, etc.)

BT.9 The student will investigate the processes of sexual and asexual plant reproduction.
Descriptive Statement: The student will learn the reproductive parts: pistil, stamen, variation in flowers, inflorescence, pollination, fertilization, and vegetative propagation.

BT.10 The student will learn about plant growth and development.
Descriptive Statement: The student will learn cell division (mitosis), also how external and internal factors such as light, temperature, chemical regulators, and tropism (plant responses) influence plants.

BT.11 The student will learn the structure and functions of fruits and seeds.
Descriptive Statement: The student will study conditions needed for seeds and fruits to mature, germinate, grow, and the method of seed dispersal.

BT.12 The student will study plant classifications.
Descriptive Statement: The student will learn the development of plant classification and use of a dichotomous key.

BT.13 The student will learn about algae and related organisms.
Descriptive Statement: The student will study about algae and related organisms and their effect on the environment.

BT.14 The student will learn about fungi and its ecological relationships.
Descriptive Statement: The student will learn the types of fungi, effects of fungi on environment, how they affect man, and the composition of lichens.

BT.15 The student will learn about the mosses, ferns, their relatives and their relationships to the environment.
Descriptive Statement: The student will learn about the structure and functions of the mosses and ferns, their place in past and present, and how they reproduce.

BT.16 The student will develop an interest in botany.
Descriptive Statement: A list of resource personnel, field trip locations, etc. should be compiled and utilized to stimulate student interest.

BT.17 The student will demonstrate knowledge of how modern technology applies basic processes and skills for an improved standard of living.
Descriptive Statement: The student will investigate careers and professional opportunities that utilize scientific knowledge and technology.

ZOOLOGY

(½–1 unit)

Zoology is a science course designed to help the student acquire habits of critical and creative thinking about animals by encouraging an appreciation for animals and their place in the environment. This will help the student develop a natural curiosity for animals and to research various ideas and scientific theories as well as to develop scientific attitudes and respect for other animal sciences. This course will also help students gain skills and scientific knowledge so the students can function in higher education or in everyday life and be able to communicate both orally and in writing with scientific proficiency. It should allow the student to learn correct scientific terms, concepts and principles, and help to further develop skills with laboratory equipment.

Concepts of Zoology:

ZO.1 The student will study the history and development of zoology.
Descriptive Statement: The student will study a brief history of zoology, from ancient to present, and the reason for studying zoology.

ZO.2 The student will study the cell.
Descriptive Statement: The student will study structure, function, and reproduction, including mitosis and meiosis.

ZO.3 The student will study protozoans.
Descriptive Statement: Students will study characteristics of common protozoa, their detailed structure, reproduction, habitat, and their relationship to other organisms.

ZO.4 The student will study the most primitive of the lower animals and their role in nature.
Descriptive Statement: The student will study the structure and characteristics of primitive animals, such as sponges, corals, sea anemones, hydra, and their relationship to the environment.

ZO.5 The student will study the lower animals called the "worms" and their relationships to other organisms.
Descriptive Statement: The student will study structure and characteristics of worms such as flukes, tapeworms, hookworms, and trichinellae, and their relationship to the environment.

ZO.6 The student will study the minor Phyla of animals.
Descriptive Statement: Students will study minor animals such as rotifers, bryozoans, brachiopods, worm-like animals, arrow worms, and their environmental importance.

ZO.7 The student will study echinoderms and mollusks.
Descriptive Statement: The student will study the structure and characteristics of echinoderms and mollusks and their relationship to the environment.

ZO.8 The student will study arthropods.
Descriptive Statement: The student will study the structure and characteristics of the classes and orders of arthropods and their relationships to the environment.

ZO.9 The student will study Chordates/vertebrates.
Descriptive Statement: The student will study the structures and characteristics of the sub-phyla, classes, and orders of Chordates.

Z.10 The student will study animal communication.
Descriptive Statement: The student will study such things as chemical messengers (pheromones), mating messages, body regulators, and how these chemicals work for mankind.

ZO.11 The student will study animal behavior.
Descriptive Statement: The student will study about instincts, internal clocks, body rhythms, and conditioning.

ZO.12 The student will study the use of pesticides and insecticides.
Descriptive Statement: Pesticides and insecticides are both beneficial and harmful depending upon their usage.

ZO.13 The student will develop an interest in zoology.
Descriptive Statement: A list of resource personnel and field trip locations should be compiled and utilized to stimulate student interest.

ZO.14 The student will demonstrate knowledge of how modern technology applies basic processes and skills for an improved standard of living.
Descriptive Statement: The student will investigate careers and professional opportunities that utilize scientific knowledge and technology.

PHYSIOLOGY AND ANATOMY

Physiology and Anatomy can be a two-semester advanced class which provides a detailed study of the structure and function of the human body. Students should have a basic knowledge of biology and physical science before enrolling in this class. Two important goals are to encourage independent research and vocabulary development.

PHA.1 The student will be able to understand basic terminology used in physiology and anatomy.
Descriptive Statement: Examples of terminology should include the body regions, surface anatomy, and body cavities.

PHA.2 The student will acquire a concept that all the body systems, organs, and tissues must interact for survival.
Descriptive Statement: The student will investigate the interaction of body systems to maintain homeostasis.

PHA.3 The student should identify the characteristics of cells which compose various tissues that carry out specific functions.
Descriptive Statement: The student will study cell anatomy and physiology, active and passive transport, and tissue types.

PHA.4 The student should identify and describe the structures and functions of the skeletal system.
Descriptive Statement: The student will identify with the use of models or pictures, the major bones, articulations, and their basic functions.

PHA.5 The student should identify structure and function of the muscular system.
Descriptive Statement: The student will study the muscular system through dissection of representative animals.

PHA.6 The student should be able to understand that the nervous system is the control center for all activities of the body and allows the human to perceive and respond to the environment.
Descriptive Statement: The student will acquire an understanding of an impulse, impulse transmission, organization, functions, and protective mechanisms of the brain.

PHA.7 The student should be able to describe the integration of the endocrine system with the nervous system in maintaining homeostasis through hormonal control.
Descriptive Statement: The student will become familiar with hormones, their origin, influences, and regulations.

PHA.8 The student should be able to understand the circulatory system.
Descriptive Statement: The student should demonstrate a knowledge of structure and functions of the heart, and blood vessels, changing composition of blood, and the immunity response of the body.

PHA.9 The student should acquire a knowledge of the structure and functions of the respiratory system.
Descriptive Statement: Emphasis should be on the breathing mechanisms and gas exchange between the blood, lungs, and tissues of the body.

PHA.10 The student should know the structure and functions of the digestive system.
Descriptive Statement: The student should be aware of the chemical processes that result in digestion and absorption.

PHA.11 The student should learn the importance of nutrition to all life processes and its relationship to good health.
Descriptive Statement: Basic food groups and caloric requirements should be included.

PHA.12 The student should study the structure and functions of the excretory system.
Descriptive Statement: The student will study the kidney, urinary bladder, and skin.

PHA.13 The student should study the structure and functions of the reproductive system, reproduction, differentation, and embryonic development.
Descriptive Statement: The student should be familiar with basic structure of the reproductive system and the stages of human development.

PHA.14 The student will develop an interest in physiology and anatomy.
Descriptive Statement: A list of resource personnel and field trip locations should be compiled and utilized to stimulate student interest.

PHA.15 The student will demonstrate knowledge of how modern technology applies basic processes and skills for an improved standard of living.
Descriptive Statement: The student will investigate careers and professional opportunities that utilize scientific knowledge and technology.

PHYSICS

Physics, as a two-semester high school course, should provide a basic understanding of the physical laws fundamental to all sciences. Adequate mathematics preparation is strongly recommended as a prerequisite. Laboratory activities are recommended because science is an investigative process.

The Suggested Learner Outcomes are to be used as a guide. The teacher should use discretion as to which areas to cover depending on the interests and abilities of the students. To quote Sire Isaac Newton, "It is better to achieve a little with certainty than a great deal that one is not sure of."

PHI.1 The student will know and use the International System of Measurements.
Descriptive Statement: The student will use metric units in calculations and understand the derivation of other metric units.

PHI.2 The student will demonstrate safe and appropriate use of laboratory techniques and equipment.
Descriptive Statement: The student will follow safe procedures in the use of lab equipment.

PHI.3 The student will demonstrate utilization of instruments to measure physical quantities.
Descriptive Statement: The student will use instruments such as meter sticks, balances, spring scales, timers, thermometers, ammeters, and voltemeters to measure quantities. The student will be able to determine the significant digits of those measurements.

PHI.4 The student will conduct, collect, analyze, and interpret results of laboratory exercises.
Descriptive Statement: The student will:
a. assemble the apparatus;
b. collect the data;
c. analyze the data;
d. construct graphs from the data if needed;
e. interpret the physical relationship from the graph or data;
f. report conclusions.

PHI.5 The student will solve problems in physics through the use of mathematics.
Descriptive Statement: The mathematical skills developed will include:
a. solving equations with one unknown quantity;
b. the use of significant digits and scientific notation;
c. be able to interpret word problems and apply the correct formulas.

PHI.6 The student will understand the differences between scalar and vector quantities and solve problems involving those quantities.
Descriptive Statement: The student will use trigonometry and/or graphs to solve vector problems by finding the resultant of at least two vectors and resolving vectors into perpendicular components.

PHI.7 The student will gain an understanding of motion and Newton's laws of motions.
Descriptive Statement: The student will solve problems and understand the relationships of speed, acceleration, time, and distance. The student will know Newton's three laws of motion.

PHI.8 The student will gain an understanding and describe mathematically the conservation of energy, matter and momentum.
Descriptive Statement: The student will learn the relationship of kinetc energy and potential energy, and elastic and inelastic collision. The student will also be able to demonstrate the transfer of heat from one system to another.

PHI.9 The student will gain an understanding of the relationship between work, power, and energy.
Descriptive Statement: Through use of formulas and laboratory experiments, the student will learn the relationships of work, power, and energy.

PHI.10 The student will identify models of transverse and longitudinal waves and apply these to the interpretation of wave phenomena.
Descriptive Statement: The student will identify such phenomena as period, wavelength, frequency, amplitude, phase, reflection, refraction, diffusion, diffraction, interference, and Doppler effect.

PHI.11 The student will identify the main segments of the electromagnetic spectrum, emphasized the properties of light.
Descriptive Statement: The segments of the electromagnetic spectrum including radiowaves, microwaves, Gamma rays, infrared radiation, ultraviolet radiation, and visible light should be described in terms of frequency and wavelength. Major applications should be discussed.

PHI.12 The student will observe and describe the fundamental processes of reflection, refraction, and image formation.
Descriptive Statement: The student will understand the laws of reflection and refraction. The student will be able to identify the type, size, and position of images formed by plane mirrors, concave and convex mirrors, and converging and diverging lenses.

PHI.13 The student will study electrical charges and the interactive forces between them.
Descriptive Statement: The student will understand positive and negative charges, as well as electrical potential energy field between like and unlike charges.

PHI.14 The student will gain an understanding of electric currents.
Descriptive Statement: The concepts involved should include a description of electric units, circuits, energy, and Ohm's law.

PHI.15 The student will be able to describe properties of permanent magnets, electromagnets and their magnetic fields.
Descriptive Statement: These properties and fields might include bar magnets, horseshoe magnets, current-bearing wire, electric coil and electric motors.

***PHI.16** The student will be able to diagram and construct simple electrical circuits and apply Ohm's and Kirchhoff's laws.
Descriptive Statement: Circuits included should be series, parallel, and combined series-parallel.

PHI.17 The student will investigate the relationship of pressure and temperature to the volume of gases.
Descriptive Statement: Investigation of behavior of gases should include Boyle's, Charles's, and combined gas laws.

***PHI.18** The student will demonstrate a basic understanding of the concepts of the nucleus, nuclear reactions, and recent developments in use and research of nuclear energy.
Descriptive Statement: The student will be able to diagram a nuclear reaction, discuss transmutation, radioactivity, and half-life. Nuclear fission and fusion should be investigated. Modern use of nuclear energy as well as future use should be investigated.

PHI.19 The student will develop an interest in physics.
Descriptive Statement: A list of resource personnel, field trip locations, etc. should be compiled and utilized to stimulate student interest.

PHI.20 The student will demonstrate knowledge of how modern technology applies basic processes and skills for an improved standard of living.
Descriptive Statement: The student will investigate careers and professional opportunities that utilize scientific knowledge and technology.

*These are enrichment topics for advanced studies.